CENTRAL ATLANTIC REGIONAL ECOLOGICAL TEST SITE (CARETS): A PROTOTYPE REGIONAL ENVIRONMENTAL INFORMATION SYSTEM

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a. Central Atlantic Regional Ecological Test Site: A Prototype Regional Environmental Information System. (ERTS-A Experiment SR-125).

b. IN-002 (NASA investigator identifier)

c. Problems impeding progress of the investigation.

Problems are still being experienced in transforming the land use maps derived from ERTS and aircraft data into digital form for further processing. In addition, increased cost and time delays in photo-processing of maps and images has been an impediment to the investigation.

d. Accomplishments during the reporting period and those planned for the next period.

While proceeding with the efforts to complete preparation of the basic CARETS maps for U.S. Geological Survey open file release, experimentation was continued with map digitizing procedures and costs of a number of options were compared. This cost information is being refined for presentation in a later report.

Contacts with users, potential users, and other outside groups seeking information about the progress of this investigation included: Metropolitan Washington Council of Governments (awaiting delivery of digitized data from land use maps covering their area); State of New York, Office of Planning Services; NASA Wallops Station; Chesapeake Research Consortium; Fairfax County, Virginia; Raytheon Autometric; Navy Department Master Planning Branch, Chesapeake

Division; Earth Satellite Corporation (interviewer representing cost-benefit study); and Frederick County (Maryland) Civic Association.

In addition, during the period of this report the opportunity presented itself for a thorough review of the CARETS project, in preparation for the investigator's status report and project review presented to a NASA panel at Goddard Space Flight Center October 24, 1973. An outline-summary of material presented at that review is contained in Section e, following.

e. Scientific results and practical applications.

Results, accomplishments to date, and expected applications of the CARETS investigation are outlined below, as presented to the ERTS Discipline Panel Review, Goddard Space Flight Center, October 24, 1973.

I INTRODUCTION AND BACKGROUND

1. CARETS - a complex and ambitious project
2. Arose in response to a need that still exists - to tie together into larger packages the results of applying remote sensing to the solution of a region's environmental problems
3. Built upon NASA's concept of ecological test sites
4. Need for interdisciplinary or regionally-integrated program packages
5. Emphasis on reaching the user with data meaningful to him in terms of solving his problems
6. Intended to be in interdisciplinary or environmental category of investigations, although "land use" is an essential component of the CARETS model

II SLIDES

1. CARETS/ERTS Investigation Objectives
2. CARETS/ERTS Investigation Flow Chart, with overlay showing tasks completed October 1973
3. Elements of CARETS Geographic Information System
4. Index to Aircraft Compiled Land Use Maps (INPUT)
5. Index to ERTS Compiled Land Use Maps (INPUT)
6. County and City Incorporated Boundaries (OUTPUT AREAS)
7. Land Use Mapping Procedures Using Aircraft Data
8. Land Use Accuracy Determination
9. Examples of Error Measurements to Date
10. Error Matrix of Photo-Interpretation Problem Areas
11. Land Use Mapping Procedures Using ERTS Data
12. CARETS Land Use Categories Identified on ERTS Imagery
13. ERTS Color Composite Image of Washington, D.C. Area
14. Land Use Map Derived from ERTS, Washington, D.C. Area
15. Digitized Land Use Area Measurement from ERTS and Aircraft Data, Norfolk-Portsmouth SMSA
16. Initial CARETS Users
17. User Evaluation - Major Steps
18. Regional Analysis Example: CARETS Shore Zone Environmental Impact

III SUMMARY COMMENTS

1. Difficulty of separating "scientific" and "applications" results

2. Need to complete the implementation of the CARETS model before new scientific results or knowledge of the environment will be available to users

3. Importance of setting standards and documenting all phases of work

4. Results thus far indicate the project is "in tune" with a set of users' needs

5. Payoff this far lies in combination of "land use" data with capability for interpretation of environmental meaning of the data

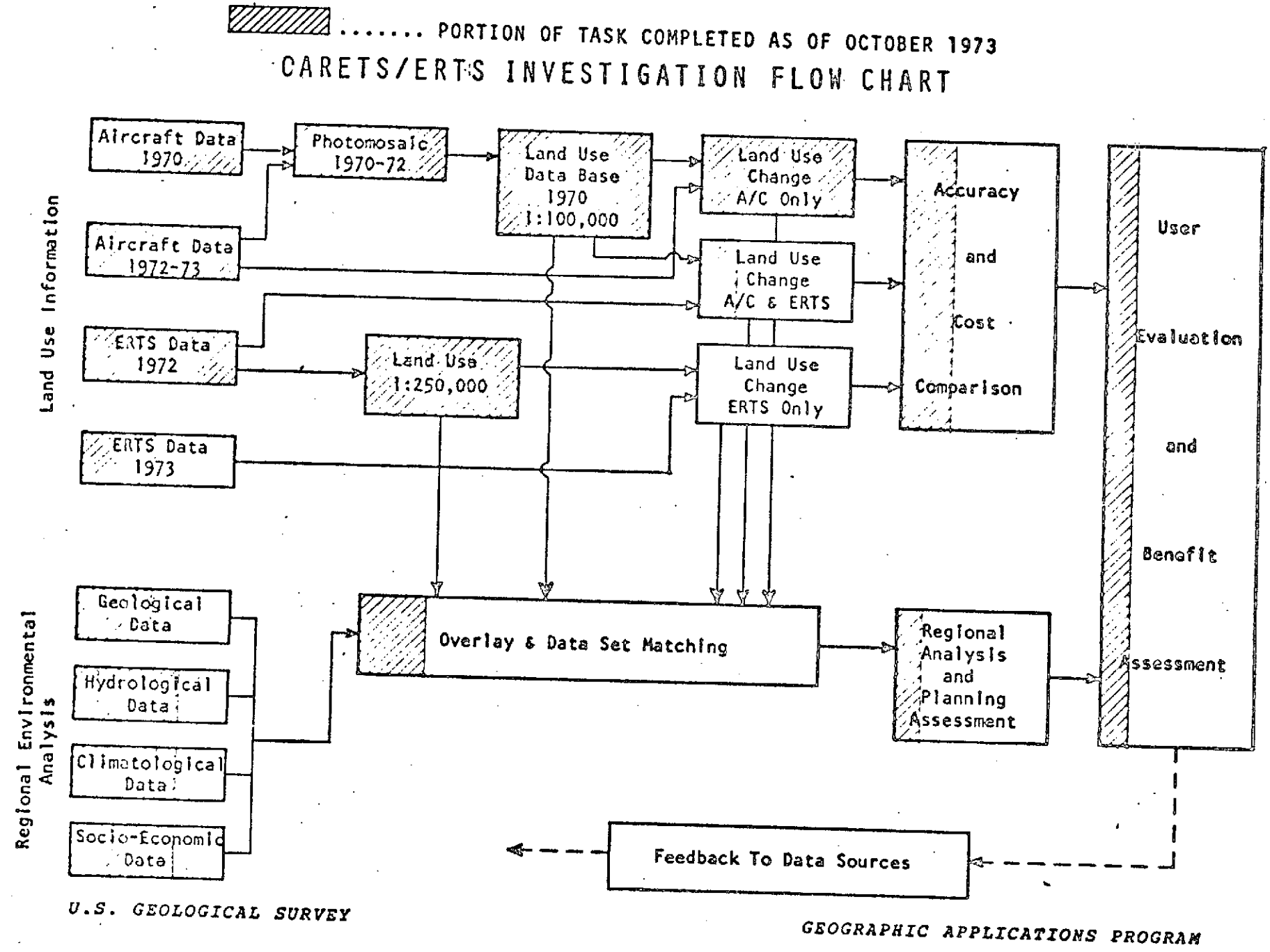
6. Project serves as prototype for new operational program - has received approximately matching funds from USGS

CARETS/ERTS INVESTIGATION OBJECTIVES

OVERALL OBJECTIVE: TEST APPLICABILITY OF DATA FROM ERTS-A AS INPUT TO A REGIONAL ENVIRONMENTAL INFORMATION SYSTEM.

SUB-OBJECTIVES:

- LAND USE ANALYSIS - PROVIDE UNIFORM QUANTITATIVE DATA SETS ON LAND USE CHANGE, SUMMED BY COUNTIES AND OTHER JURISDICTIONAL AREAS; MAKE QUANTITATIVE COMPARISONS OF ERTS AND AIRCRAFT DATA.
- ENVIRONMENTAL IMPACT ASSESSMENT - PERFORM SAMPLE ANALYSES OF LAND USE DATA SETS IN TERMS OF ENVIRONMENTAL IMPACT OF LAND USE PATTERNS AND CHANGES.
- USER EVALUATION - PROVIDE FOR EXPERIMENTAL USE AND CRITIQUE OF RESULTS BY REPRESENTATIVE USER INSTITUTIONS.


..... PORTION OF TASK COMPLETED AS OF OCTOBER 1973
CARETS/ERTS INVESTIGATION FLOW CHART
Land Use Information
Aircraft Data 1970
Photomosaic 1970-72
Land Use Data Base 1970 1:100,000
Land Use Change A/C Only
Aircraft Data 1972-73
Land Use Change A/C & ERTS
ERTS Data 1972
Land Use 1:250,000
Land Use Change ERTS Only
ERTS Data 1973
Accuracy and Cost Comparison
User Evaluation and Benefit Assessment
Regional Environmental Analysis
Geological Data
Hydrological Data
Climatological Data
Socio-Economic Data
Overlay & Data Set Matching
Regional Analysis and Planning Assessment
Feedback To Data Sources
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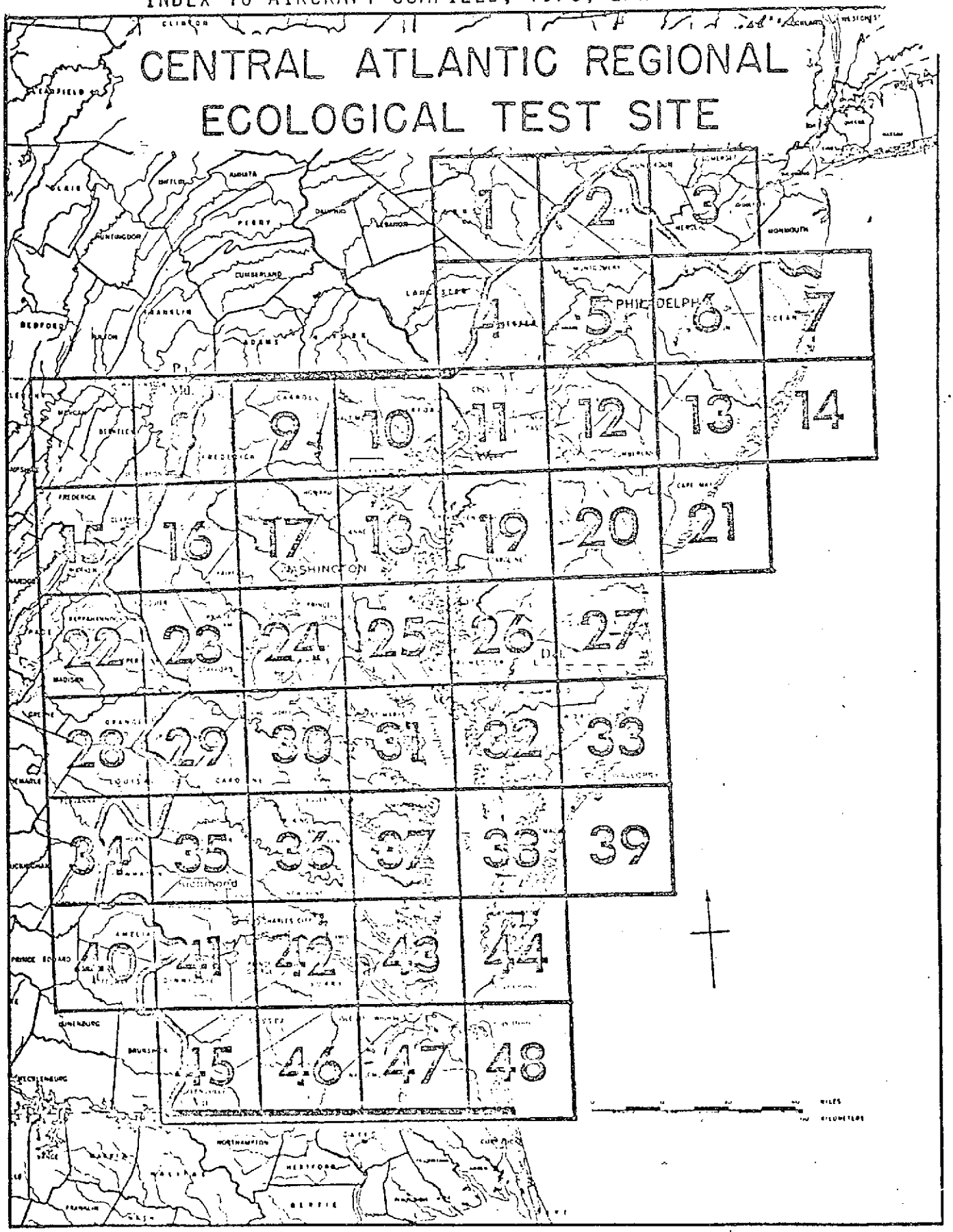
ELEMENTS OF CARETS GEOGRAPHIC INFORMATION SYSTEM

- USER NEEDS ASSESSMENT
- PREPARATION OF MAPS FOR DIGITIZING
- DIGITIZING MAP DATA
- PROCESSING DATA FOR CONVERSION TO POLYGON FILE
- PLOTTING, EDITING AND CORRECTING ERRORS
- PREPARATION OF AREA SUMMARIES BY COUNTY AND CENSUS TRACT
- MERGING OF LAND USE CHANGE AND HOLIDAYS TO PRODUCE 1972 AIRCRAFT UPDATE MAP
- OVERLAYING OF LAND USE MAPS WITH CENSUS, HYDROLOGY AND GEOLOGY MAPS
- STATISTICAL ANALYSIS OF DIGITIZED DATA
- USER EVALUATION AND FEEDBACK

INDEX TO AIRCRAFT COMPILED, 1970, LAND USE MAPS



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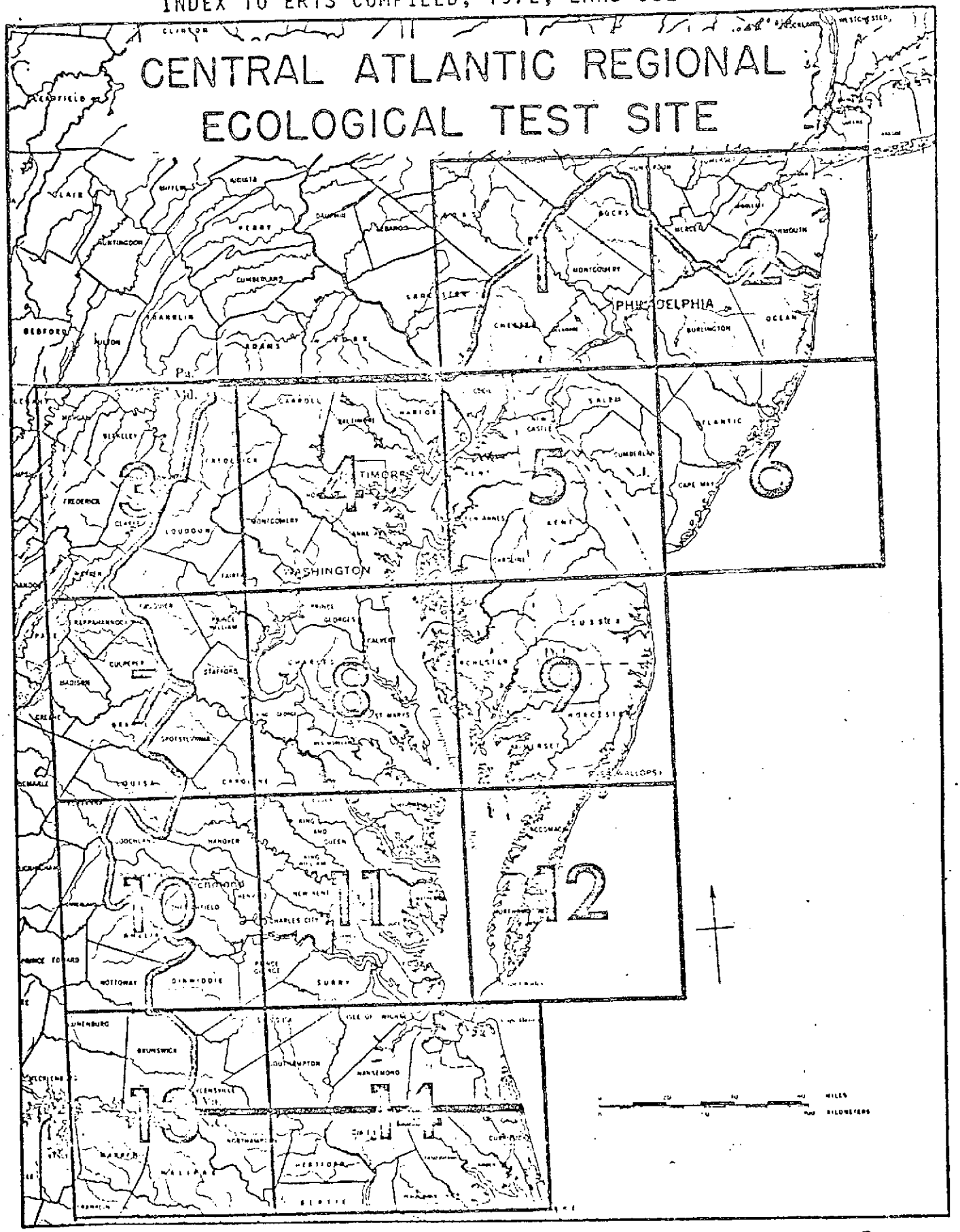
INDEX TO ERTS COMPILED, 1972, LAND USE MAPS



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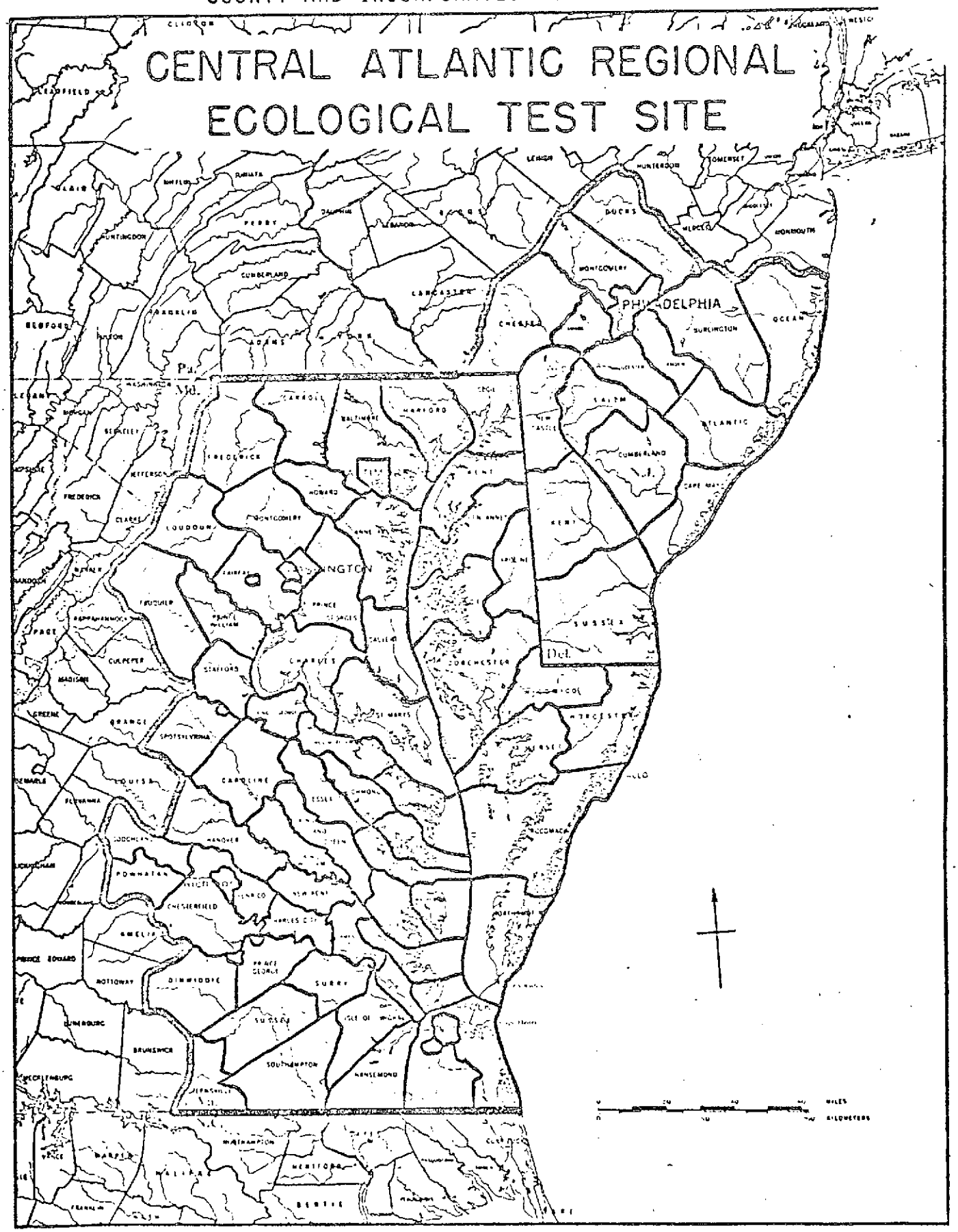
COUNTY AND INCORPORATED CITY BOUNDARIES



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LAND USE MAPPING PROCEDURES USING AIRCRAFT DATA

- RECEIPT OF AERIAL PHOTOGRAPHY FROM NASA
- COMPILATION OF RECTIFIED PHOTO-MOSAICS
- INTERPRETATION AND COMPILATION OF LAND USE MAPS (1:100,000)
  - SELECTION OF CLASSIFICATION SYSTEM (LEVEL II)
  - IMAGE INTERPRETATION PROCEDURES
- EDITING OF LAND USE MAPS; DETERMINING MAP ACCURACY
- INTERPRETATION AND COMPILATION OF LAND USE CHANGE MAPS (1:100,000)
- EDITING OF LAND USE CHANGE MAPS
- PHOTO REPRODUCTION OF LAND USE AND LAND USE CHANGE MAPS
- PREPARATION OF MAPS FOR DIGITAL TRANSFORMATION

LAND USE ACCURACY DETERMINATION

1. ERROR DUE TO HORIZONTAL DISPLACEMENT OF MAPPED DATA
   - MAP PROJECTION ERRORS
   - PHOTOGRAMMETRIC ERRORS IN BASIC MOSAIC
   - DIMENSIONAL INSTABILITY OF PAPERS AND FILMS
   - DIGITIZING AND COMPUTER PROCESSING ERRORS
2. AGGREGATION ERROR DUE TO CHANGE FROM LARGE SCALE TO SMALL SCALE UNITS
3. PHOTO-INTERPRETATION ERROR
4. ERROR DUE TO CLASSIFICATION SYSTEM
5. ERROR DUE TO LAND USE CHANGE
6. COMBINED EFFECTS RESULTING FROM ALL ERROR SOURCES

EXAMPLES OF ERROR MEASUREMENTS TO DATE

- PHOTOGRAMMETRIC MEASUREMENT OF LAND USE
- COMPARISON OF LAND USE ACCURACY DATA AT 1:250,000; 1:100,000; 1:24,000 FOR SITES IN NORFOLK
- FIELD VERIFICATION TO TEST ACCURACY OF PHOTO INTERPRETATION
- RANDOM SAMPLING OF LAND USE ACCURACY FOR THE EASTERN SHORE OF MARYLAND BY HELICOPTER
- RANDOM SAMPLING OF LAND USE ACCURACY FOR 30 SITES (100 Km^2) FOR THE ENTIRE CARETS REGION
- RANDOM SAMPLING OF LAND USE ACCURACY FOR NORFOLK
- STATISTICAL ANALYSIS OF ALL SAMPLING RESULTS FOR ACCURACY DETERMINATION

ERROR MATRIX OF PHOTO INTERPRETATION PROBLEM AREAS

LAND USE FIELD CHECKED (1972) PERCENT OF TOTAL*

LAND USE INTERPRETED (1970) PERCENT OF TOTAL*

	11	12	13	14	15	16	17	18	19	21	22	23	24	41	42	61
11	2.3															
12	1.0	7.5	5.1			1.6		7.4								
13		1.2	7.9					1.0								
14		1.0	1.3	1.0												
15					0.1											
16						5.0										
17							0.0									
18								0.1								
19									5.9							
21										3.6					1.7	4.1
22											0.2					
23												0.1				
24													0.0			
41														12.0		
42										4.4				1.6	1.6	
Percent of Total	4.4	10.8	15.4	1.5	1.0	7.5	0.2	8.6	7.7	8.7	2.0	1.0	0.1	14.0	4.3	6.2

AREA FIELD CHECKED 8,609 HA.; DIAGONAL REPRESENTS CORRECT INTERPRETATION

AREA IN CARETS SHEETS USED FOR FIELD CHECK 3,450,000 HA.

PERCENT OF PROBLEM AREAS IN CARETS SHEETS TESTED <1.0%

*TWO-DIGIT LAND USE CODE FROM USGS CIRCULAR 67.

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LAND USE MAPPING PROCEDURES USING ERTS DATA

- RECEIPT OF ERTS 70mm POSITIVE AND NEGATIVE TRANSPARENCIES
- ORDERING OF ERTS COLOR COMPOSITE TRANSPARENCIES, SCALE 1:250,000, AS A MAPPING BASE
- USE OF AIRCRAFT PHOTOGRAPHY AS A TRAINING SET WITH ERTS
- PREPARATION OF 14 LAND USE MAP OVERLAY SHEETS ON DRAFTING FILM FROM COLOR COMPOSITES
- EDITING OF LAND USE MAPS
- DETERMINING LAND USE MAP ACCURACY
- COMPILATION OF LAND USE CHANGE
- PREPARATION OF MAPS FOR DIGITIZING

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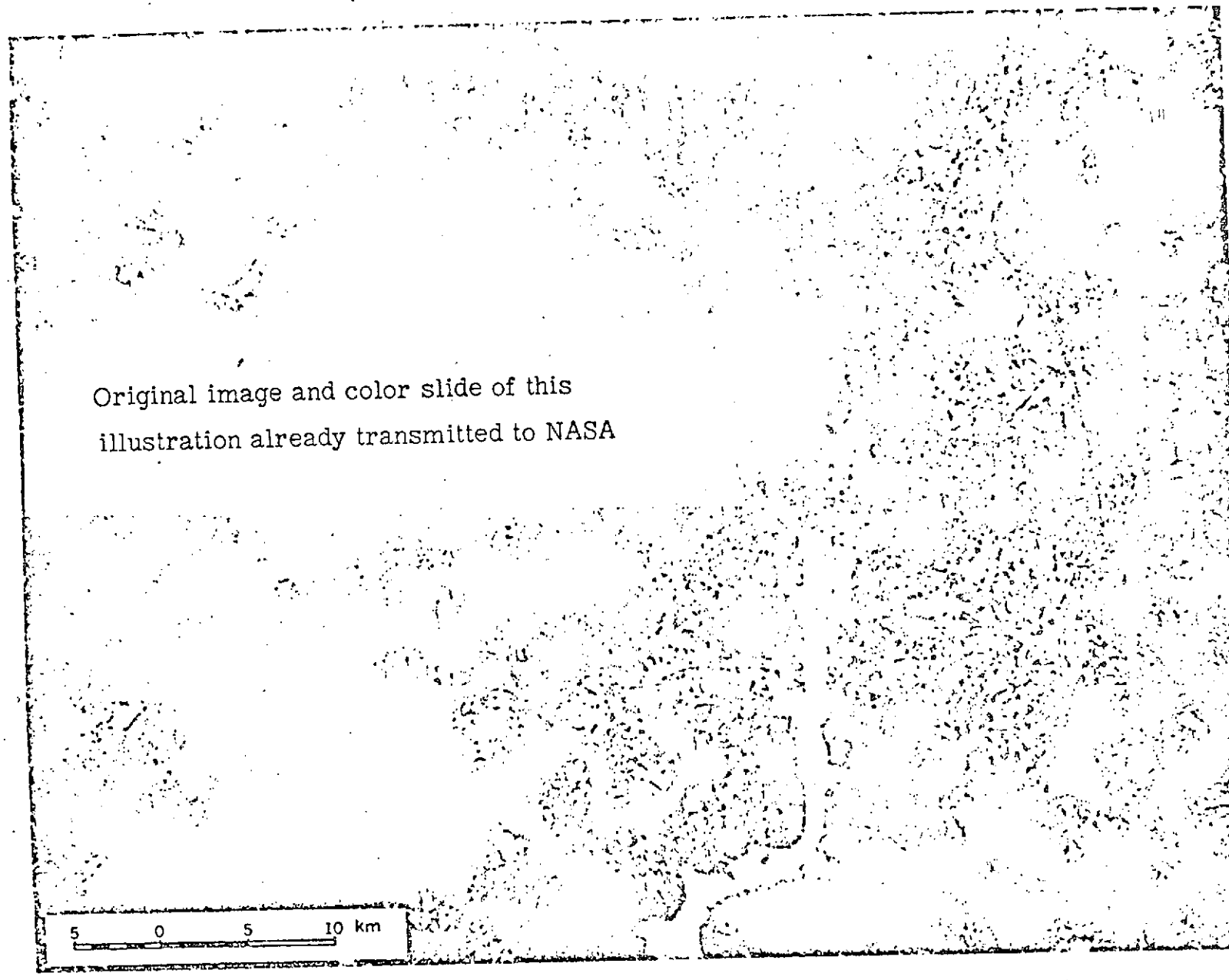
CARETS LAND USE CATEGORIES IDENTIFIED ON ERTS IMAGERY

LEVEL I	LEVEL II	LEVEL III (PROPOSED)
1 URBAN AND BUILT-UP	11 RESIDENTIAL	111 SINGLE FAMILY RESIDENTIAL UNITS
	12 COMMERCIAL AND SERVICES	121 RETAIL TRADE AREAS
	14 EXTRACTIVE	142 SAND AND GRAVEL PITS
	15 TRANSPORTATION, COMMUNICATION AND UTILITIES	151 HIGHWAYS
		152 RAILROADS AND FACILITIES
		153 AIRPORTS
		154 MARINE CRAFT FACILITIES
	16 INSTITUTIONAL	
	17 STRIP AND CLUSTERED SETTLEMENT	
	18 MIXED	
	19 OPEN AND OTHER	
2 AGRICULTURAL	21 CROPLAND AND PASTURE	
4 FOREST	41 DECIDUOUS FOREST	
	42 EVERGREEN FOREST	
5 WATER	51 STREAMS AND WATERWAYS	
	52 LAKES	
	53 RESERVOIRS	
	54 BAYS AND ESTUARIES	
6 NON-FORESTED WETLAND	61 VEGETATED	
	62 BARE	
7 BARREN LAND	74 BEACHES	

ERTS Color Composite Image of the Washington, DC Area

(Frame 1080-15192/Bands 4,5,7/11Oct72)



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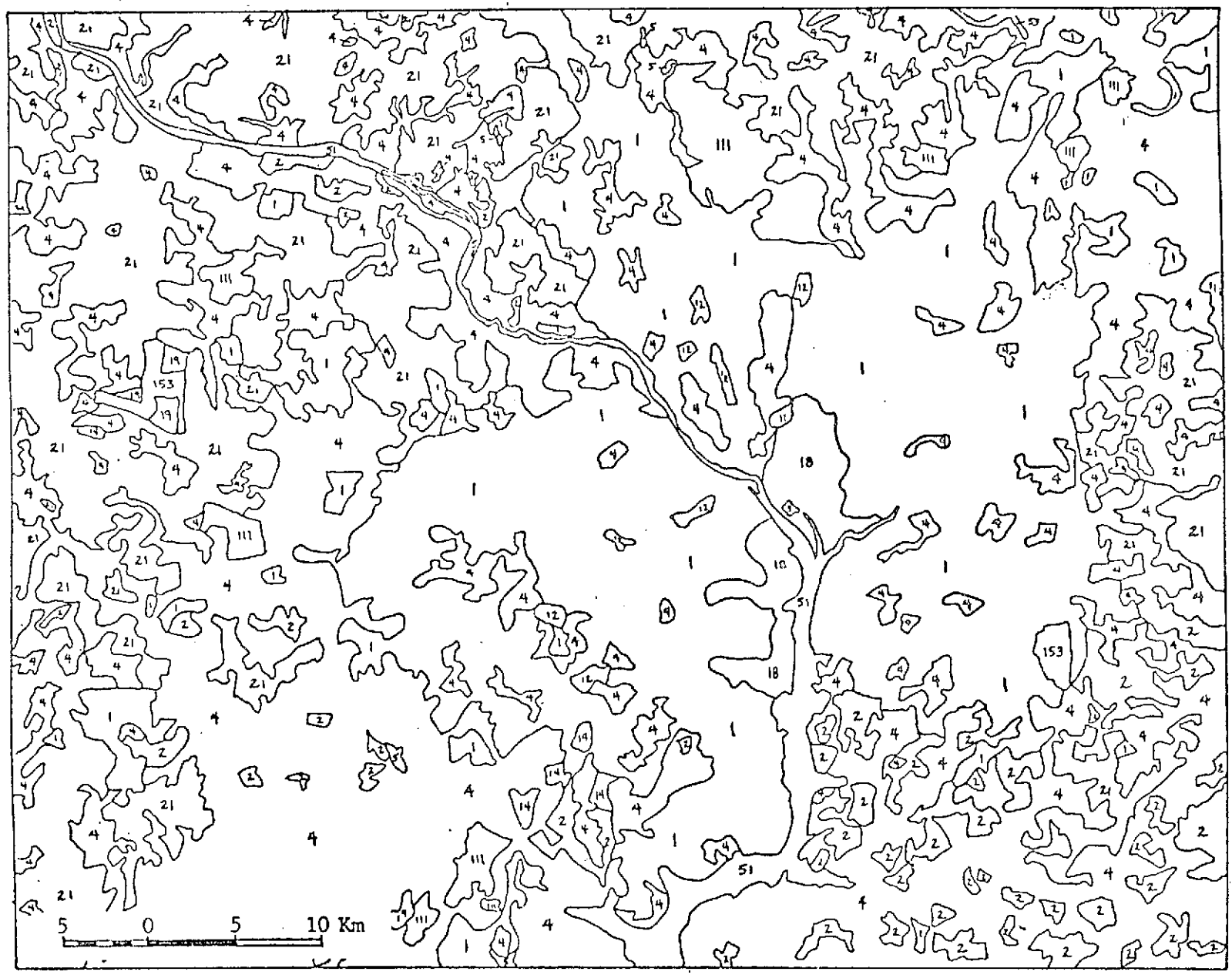
Washington Area Land Use Map Derived From ERTS



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DIGITIZED LAND USE AREA MEASUREMENT FROM ERTS AND AIRCRAFT DATA NORFOLK-PORTSMOUTH SMSA

	1970 AIRCRAFT DATA (IN HECTARES)	1972 ERTS DATA (IN HECTARES)
URBAN	40,521	46,602
AGRICULTURE	48,746	46,833
FOREST	75,449	72,993
NON-FORESTED WETLAND	4,530	7,772
BARREN	26	1,729

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INITIAL CARETS USERS

- U.S. ARMY CORPS OF ENGINEERS
- STATE OF MARYLAND
- STATE OF VIRGINIA
- METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS
- NORTHERN VIRGINIA PLANNING DISTRICT COMMISSION
- SOUTHEAST VIRGINIA PLANNING DISTRICT COMMISSION
- FREDERICK COUNTY, MARYLAND

USER EVALUATION -- MAJOR STEPS

- MAKING AND MAINTENANCE OF USER CONTACTS
- INITIAL USER INTERVIEWS
  - LIST CARETS PRODUCTS AND AVAILABILITY SCHEDULE
  - USER PACKET OF SAMPLE PRODUCTS
  - DATA DISTRIBUTION INFORMATION QUESTIONNAIRE
  - DATA REQUIREMENTS QUESTIONNAIRE
- USER FOLLOW-UP CONTACTS -- DATA UTILITY EVALUATION
- USER EVALUATION RESPONSE ANALYSIS
- USER BENEFIT ASSESSMENT

REGIONAL ANALYSIS EXAMPLE: CARETS SHORE ZONE ENVIRONMENTAL IMPACT

- ERTS/AIRCRAFT/GROUND OBSERVATIONS
  - LAND USE AND ASSOCIATED TERRAIN FEATURES
  - ESTABLISH PATTERNS AND RATES OF CHANGE
  - BEACH, DUNE, VEGETATED ZONE, WETLAND, LAGOON ENVIRONMENTS
- OTHER DATA INPUTS
  - SURFICIAL MATERIALS CHARACTERISTICS
  - HYDROLOGICAL AND SEA LEVEL TRENDS
  - WAVE ACTION
  - CLIMATOLOGICAL DATA: STORM TRENDS
  - BIOLOGICAL OBSERVATIONS, INCLUDING MAN'S MODIFICATIONS
- IMPROVED UNDERSTANDING OF SHORE ZONE PROCESSES AFFECTING LAND USE
- CONCLUSIONS: SHORELINE CHANGE "NATURAL" STATE IN BARRIER ISLAND ENVIRONMENT
- MANAGEMENT STRATEGY AND DECISION: DISCONTINUE ARTIFICIAL BEACH AND DUNE STABILIZATION (NATIONAL PARK SERVICE)

f. Published reports or talks:

None.

g. Recommendations for improvement:

None.

h. Changes in standing order forms:

None.

i. ERTS image descriptor forms:

See attached.

j. Data request forms submitted:

None.

k. Status of data collection platforms (if applicable):

N/A.